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ENTOMOLOGICAL EVALUATION OF MALATHION AS A RESIDUAL SPRAY FOR THE CONTROL OF *ANOPHELES CULICIFACIES* IN THE PROVINCE OF HELMAND, SOUTHWEST AFGHANISTAN, 1976¹

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ABSTRACT. A field trial evaluation of malathion was carried out in the province of Helmand, southwest Afghanistan, in order to evaluate the effectiveness of this insecticide for control of adult anopheline mosquitoes. *Anopheles culicifacies* Giles is one of the main vectors of malaria, with an epidemic potential in the lower Helmand province, that showed a

strong resistance to DDT in 1972.

One round of house spraying with malathion 50% w.d.p. 2g/m² was carried out in July 1976, at the peak of activity of *An. culicifacies*. On the basis of the results obtained, it was concluded that malathion is an effective insecticide against *An. culicifacies*.

INTRODUCTION

After the development of DDT resistance in *Anopheles culicifacies* Giles, the main vector of malaria in southwest Afghanistan, in 1972, the number of malaria cases in the lower Helmand province, with a population of 207,334, has steadily increased (Malaria Institute, Kabul, unpublished document). Lower Helmand province had been treated with DDT 75% w.d.p., 1.5 g/m², 18 rounds once a year during 1953-74, and one

round of malathion 50% w.d.p., 2g/m² in 1975 for malaria control.

Various entomological observations indicate that *An. culicifacies* persists in this area with high densities during June-September, biting man and animals, particularly during the season when people and animals sleep outdoors. *An. stephensi* starts its activity from about late August. *An. pulcherrimus* is regarded as a suspected vector in this area, and mostly rests in outside shelters.

During the course of preliminary surveys carried out in 1950-52 (Dhir and Rahim 1957) *An. superpictus* was considered to be the main and only vector in northern and mountainous valley of Helmand.

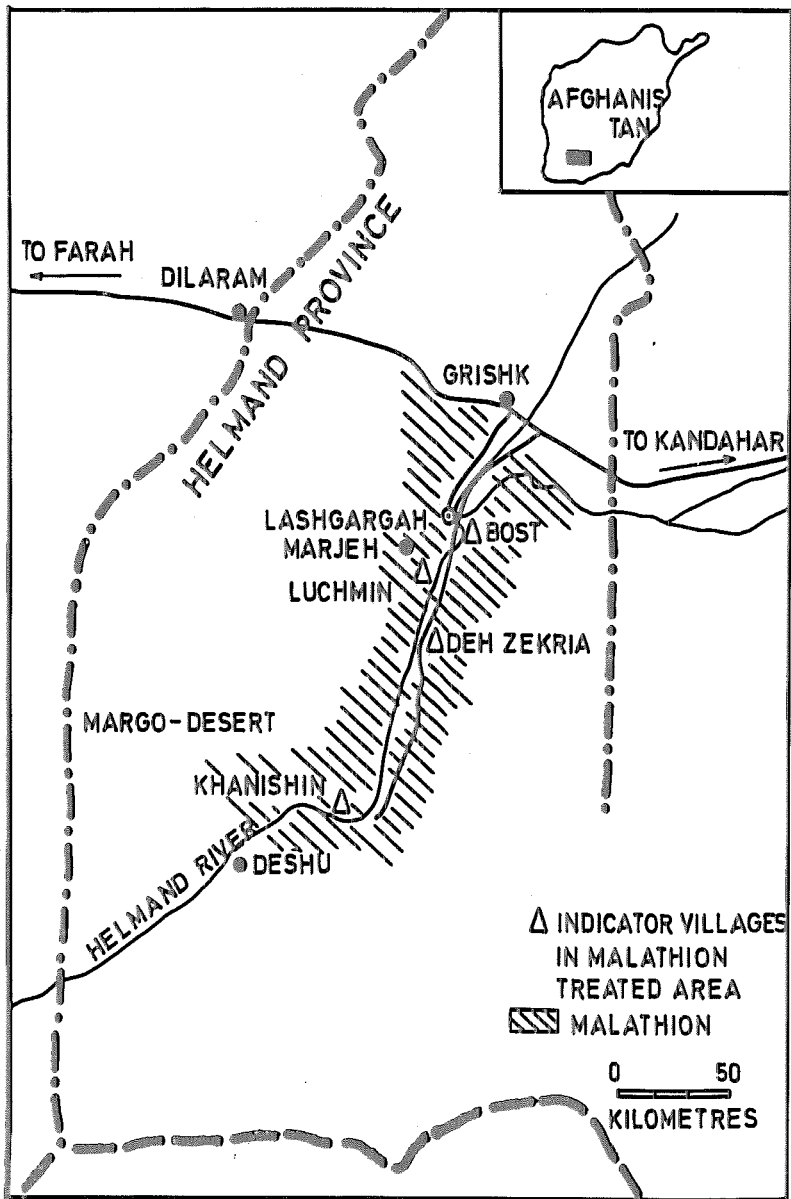
MATERIAL AND METHOD

THE STUDY AREA. Lower Helmand

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Map showing operational area treated with malathion in the lower Helmand Province, South West Afghanistan

province is a vast semi-arid plain, characterized by a desert climate, and generally it has hot summers. The rainfall is scanty and humidity remains low during most of the year. The most important river in this province is the Helmand, which rises in the central highlands and, after flowing through the Hazarajat, descends to Grishk and Lashgargah finally disappearing into the lake of Seistan (see map).

Irrigation in Helmand province is by a system of canals branching from river and streams at higher reaches and leading to the fields situated at lower levels. The dwellings are built of sun-dried bricks covered with mud. During the hot seasons temporary huts are made from wood and leaves. Malaria transmission usually occurs 6 months of the year, mid May–mid November.

The main types of breeding places in this area are drainage ditches, irrigation canals, surface water, river-bed pools, marshes and swamps of various sizes, pools from seepage water and hoofprints. One round of spraying with malathion 50% w.d.p. 2g/m² (technical) was carried out in 168 villages with a population of 166,698 inhabitants in July 1976.

EPIDEMIOLOGICAL DATA

Early control measures using DDT residual spraying were begun in the province of Helmand in 1953. Malaria control continued until 1958 when, on the basis of the excellent results obtained, it was decided to embark on a Malaria Eradication Programme. Under the impact of the attack measures implemented during the first years of the Malaria Eradication Programme, the epidemiological situation evolved very favourably, to such an extent that in 1962 some areas were transferred into the consolidation phase. In 1968 and the following years the number of positive cases increased considerably, and epidemics finally appeared, in the south and southwest (1970). The epidemiological data in

Helmand province during 1966–76 are given in Table 1.

These data are based on the annual parasite incidence (A.P.I.) per 1000 population per year or positive cases per 1000 population per year and annual blood examination rate (ABER) or number of the blood slides examined per 100 population per year. The rates show an increase in API; API ‰ from 0.22 in 1966 to 14.9 in 1971 and 30.3 in 1976.

METHOD OF ENTOMOLOGICAL EVALUATION. Four representative villages were chosen for entomological evaluation. The studies were carried out at 15-day intervals. The following measures were conducted in malathion treated areas:

1. Pyrethrum spray collection—at 8 fixed capture stations in each indicator village.
2. Larval collection—for additional evidence of the persistence of vector anopheline mosquitoes;
3. Window trap collection—a total of 8 exit traps were installed in a number of houses and live specimens were observed for 24 hours mortality;
4. Floor sheet collection—the number of dead mosquitoes found on sheets spread overnight on the floors of 6 sprayed shelters were counted;
5. Shelter pit collection—8 artificial pits were estab-

Table 1. Result of epidemiological data in Helmand province, southwest Afghanistan during 1966–76

Year	Rates	
	ABER %	API ‰
1966	8.3	0.22
1967	9.1	0.05
1968	14.3	0.09
1969	11.5	0.28
1970	18.8	0.54
1971	18.3	14.9
1972	12.9	4.6
1973	9.6	1.3
1974	15.7	16.2
1975	19.5	20.4
1976	22.8	30.3

ABER = Annual blood examination rate

API = Annual parasite incidence

lished in two villages and were examined at fortnightly intervals; 6. Vector age determination—Detinova's method (1962) carried out in sprayed villages; 7. Night biting collections—on human and animal bait; 8. Susceptibility tests using the WHO technique (WHO, 1970) with DDT, dieldrin and malathion were conducted.

RESULTS AND DISCUSSION

An. culicifacies is considered to be the main vector of malaria in this area and plays an important role from May to September. *An. stephensi* seems to have played the more important role from late August to October. *An. culicifacies* is a predominantly house-resting anopheline that feeds avidly on animals but also feeds readily on man. *An. culicifacies* was found in very large numbers inside human dwellings and stables during the day.

Coverage of the area with malathion resulted in a considerable decline in the population of *An. culicifacies*, (Figs. 1-4).

Morning resting densities were measured from 7 a.m. to 10 a.m. The mos-

quitoes were grouped by species, sex and abdominal condition. Pyrethrum spray collections of *An. culicifacies* from houses in the 4 indicator villages before malation house spraying totalled 2199 females and 305 males over the 30-day period prior to the spraying.

The number of half-gravid and gravid females was 1151 (52.3%). The average density for *An. culicifacies* in the 4 indicator villages was 57.5 per shelter in the first half of July before spraying. Indoor densities for other species were low and only 1 *An. stephensi*, 9 *An. superpictus* and 5 *An. pulcherrimus* were caught during the pre-spray period.

In July, 5 days after the spraying, only 17 *An. culicifacies*, all blood-fed females, were found in pyrethrum spray collections. During August-October a total of 164 *An. culicifacies* females was found and the number of half-gravid and gravid was 31 (18.9%). The densities per shelter ranged between 0.3-1.6 for *An. culicifacies*; 0.25-12.1 for *An. stephensi* and 0.03-2.1 for *An. pulcherrimus*, between 5 and 95 days after the malathion application.

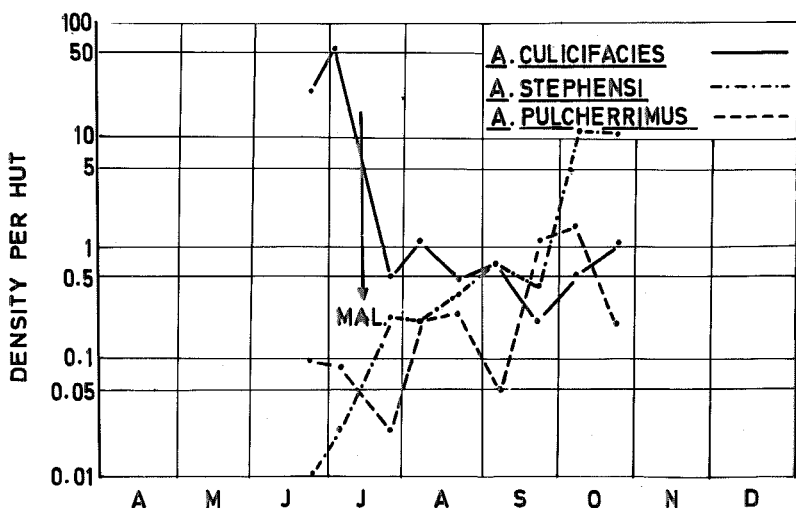


Fig. 1. Anopheline indoor density in the malathion treated villages—lower Helmand Province, South West Afghanistan, 1976.

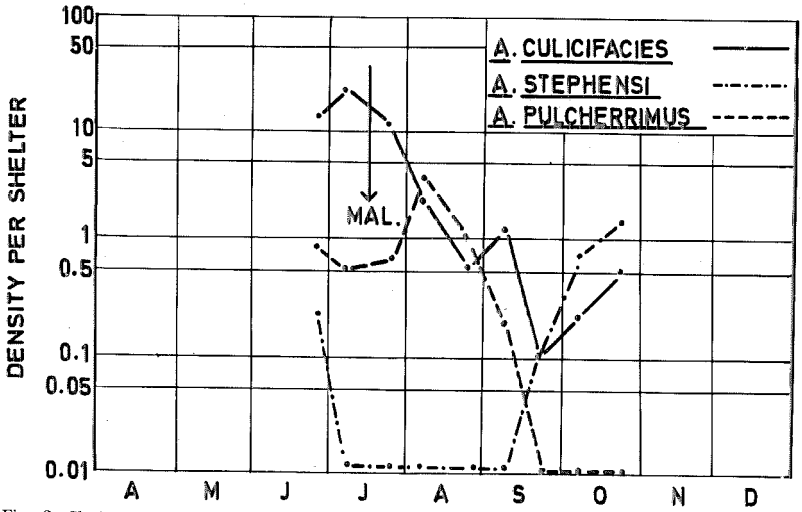


Fig. 2. Shelter pit collections of anophelines in the malathion treated villages—Lower Helmand Province, South West Afghanistan, 1976.

During the corresponding period in the unsprayed village of Marjeh, the mean *An. culicifacies* density per indoor shelter was 12.2 and 29.6 for the months of August-September, and the mean *An. stephensi* density were observed to be 20.2,

77.1 and 52.8 per hut in August, September and October respectively.

Shelter pit surveys for *An. culicifacies* showed the maximum density of 26.5 per pit before malathion application. The number of empty, blood fed, half gravid

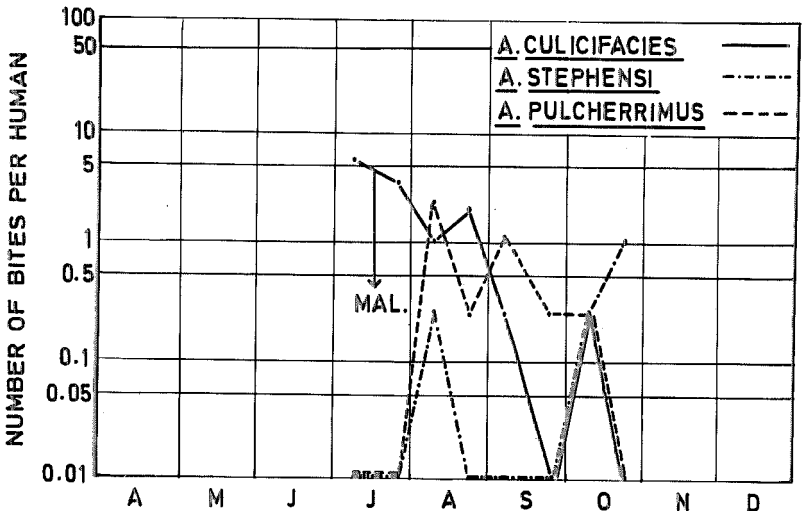


Fig. 3. Night biting catches on human bait in the malathion treated village of Bost—Lower Helmand Province, South West Afghanistan, 1976

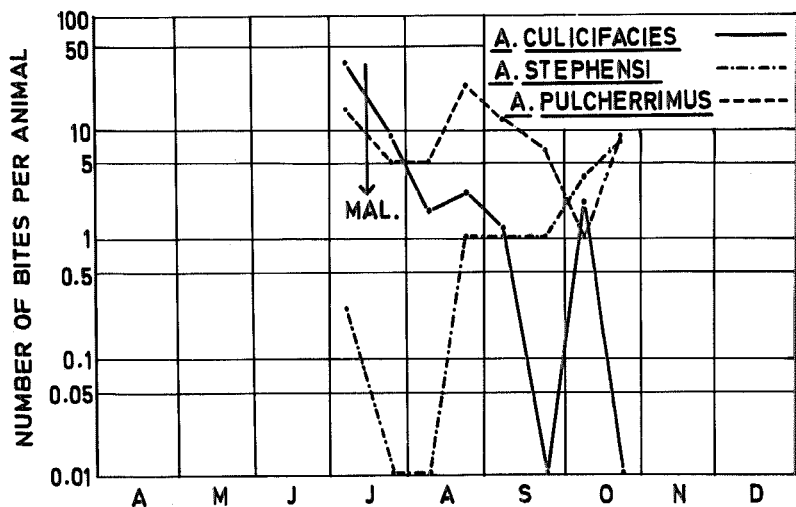


Fig. 4. Night biting catches on animal bait in the malathion treated village of Bost—Lower Helmand Province, South West Afghanistan, 1976

and gravid females was observed; 124 (58.5%), 33 (15.6%), 20 (9.4%) and 35 (16.5%), respectively. The density of *An. culicifacies* per pit shelter ranged between 11.1 and 0.1 after the spraying, from the second half of July to October.

Exit trap observations were carried out twice during the pre-spray period and 94 *An. culicifacies* females were collected, with a mortality of 11.5% and 11.7% respectively, after a 24-hour observation period. The indices of empty, blood fed, half-gravid and gravid *An. culicifacies* females trapped were 17.6%, 26.5%, 13.2% and 42.7% respectively.

After malathion application, mosquitoes captured in exit traps were kept for observation and the range of mortality was observed to be between 66.7/100%, during 50 days after spraying. Among the collected mosquitoes, no later stages of blood digestion were seen.

During the 50 days after spraying with malathion, a total of 102 *An. culicifacies* females plus 55 males and a few *An. superpictus* and *An. pulcherrimus* were collected on sheets spread overnight on the floors. The finding of dead mosquitoes on floor sheets indicates that malathion

insecticidal contact was lethal to these mosquitoes.

Larval collections were made from various breeding habitats. *An. culicifacies* utilizes a wide variety of situations, but fresh clean water is usually preferred. A considerable number of *An. culicifacies* larvae were collected from the banks of the main and secondary irrigation canals during the course of the study (June-October).

Night-biting collections of *An. culicifacies* during the pre-spray period averaged 5.5 per night bait on man and 42.3 on animal in the first half of July. During the 95 days after malathion spray application, the number per bait per night on man ranged from 4 to 0 on man and 9 to 0 on animals. The inhabitants sleep outside during July-October and thus the catches were made almost entirely outdoors.

Ovary dissections on 230 *An. culicifacies* collected from indoors and 100 from outdoors revealed an average parous rate of 57.3% and 52% respectively before malathion application. During the 5-35 days after malathion spraying the parous rate of a total of 56 *An. culicifacies* from

indoor collections and 52 outdoor samples, revealed a parous rate of 14.3% and 17.3% respectively

Susceptibility tests using the WHO technique were carried out on *An. culicifacies*. The tests were made on mosquitoes from the localities of Bost, Luchmin and Khanishin, in the lower Helmand province, during July 1976.

Mortality rates for 4.0% DDT after 1 hr exposure and 24 hr recovery were 3.1–26.8%. When the time of exposure was increased to 4 hr, the mortality rates were between 50–65.1%.

Susceptibility tests with dieldrin concentrations at 1 hr exposure revealed that the LC50's were 0.08–0.11%.

With 3.2 malathion papers, the LT50's were observed to be between 10.5 and 16.5 min, and with a 5.0% malathion concentration the LT50's were between 6 and 7 minutes.

Considering the nature of the area, the living manner of the indigenous people, the type of buildings which are mostly made from sun dried bricks, and the results of the entomological studies made in the area, it was concluded that the malathion spraying gave satisfactory control of *An. culicifacies*, the largely endophilic species, for about 2 months.

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